SCIENTIFIC AMERICAN™

Permanent Address: http://www.scientificamerican.com/article/oceans-could-lose-1-trillion-in-value-due-to-acidification/

Energy & Sustainability » Climatewire

Oceans Could Lose $1 Trillion in Value Due to Acidification

A very young field of research is trying to measure the costs of oceans growing more acidic

ClimateWire

October 21, 2014 | By Jennifer Huizen and ClimateWire |

This month, the U.N. Convention on Biological Diversity released a report updating the impacts of ocean acidification on marine life. This time, it put estimated costs on the predicted damage, hoping to make governments aware of the potential size of the various threats.

Corallines, corals, goldies, reef and surface at Halahi Reef, Red Sea, Egypt.
Credit: Derek Keats via Flickr

While many of the effects of growing acidification remain invisible, by the end of this century, things will have changed drastically, the report found. One estimate looking only at lost ecosystem protections, such as that provided by tropical reefs, cited an economic value of $1 trillion annually.

Over the last 200 years, the world's oceans have absorbed more than a quarter of the carbon dioxide released by humans, becoming 26 percent more acidic. Though technically waters have not yet become acidic, according to the pH scale, the report found this could occur by 2100 if emissions continue to rise.

Though large, these changes are still difficult to comprehend, said Murray Roberts, a professor of marine biology at Heriot-Watt University in Edinburgh, Scotland, who co-edited the report. That's why the economics of ocean acidification need to be discussed, he said.

"We tried to give as much of an economic and governmental context as we could to the report, highlighting the areas we can work to change now," said Roberts. "Yet there remains a huge level of uncertainty at this level; there just aren't a great deal of key references to go by."

Roberts, who works with deep-sea corals, said the report is a starting point. While areas of study like his remain mostly elusive, work with tropical counterparts is generating the foundation for further work.

"We used what we have right now," he said, "which I think has generated the beginnings of what will become a much more detailed conversation."

Food security impact may be large

Ocean acidification, first discussed in the 1990s, didn't become a well-documented trend until 2004. But since then, the number of researchers entering the field has grown substantially. From 2004 to 2013, the report found, studies published on the topic grew twentyfold.

"This alone warranted an update to the report," said Roberts.

But it wasn't the only factor; the whole scope of the 2009 study needed to be altered to reflect reality, he explained.

"In 2009, we didn't take into consideration societal implications, loss of ecosystem services or policy at all," said Roberts. "But by just looking at an example such as tropical reefs, it's clear destruction of these reefs can lead to decreased food security, income loss, shoreline damage and much more."

The most recent report used four fundamental ecosystem services -- provisional (food sources), regulatory, cultural and supporting services like coastal protection -- as criteria to help characterize the impacts of acidification.

Of the 400 million people cited to live within 62 miles of tropical reefs, many rely on these fish habitats for their livelihoods and a vast majority of their protein intake. So negative impacts on reefs represent a direct threat to human populations, explained Roberts.

"Children watch 'Finding Nemo' and other such films, [which] is great and shows just how far we've come in educating the public about these environments, but most still think corals are a rock or a plant, not an animal," he said. "Most of us remain divorced from the ocean."

The list of unknowns grows

Philip Munday, a marine biologist at James Cook University in Queensland, Australia, who helped author the report, added: "Ocean acidification is a very young field, but if you look at what we've learned even in the past five years, it's pretty encouraging. And realistically, a lot of the worst impacts we predict are decades out. This gives us time to make changes."

Munday, who has worked on the effects of warming and ocean acidification on fish, said that with rapid advancements in the field came whole new suites of unanticipated questions.

A selection from Washington state's oyster crop that is already suffering from ocean acidification. Photo courtesy of Gov. Jay Inslee.

The 2009 study only looked at the impacts of acidification on calcifiers, organisms that build shells ranging from plankton to commercial crustaceans. It failed to consider genetic adaption potential, explained Munday.

While shell-making species will certainly be affected by acidification, as the forms of elements they require to build and maintain their shells disappear under lower pH conditions, they are certainly not the only organisms at risk.

"When I began, almost nothing was known about how fish would react to these kind of steady increases in carbon dioxide. Past studies all looked at instantaneous large increases and how organisms physiologically responded," he said.

On this front, fish have more flexibility, he said. Under high levels of CO2, fish can maintain internal pH by monitoring ions in their blood and accumulating bicarbonate, but at a cost of expended energy.

"The question changes from whether fish can survive under future conditions to how much it will cost them to survive in these conditions," he said.

The report also found that shellfish have some adaptive capability. It described case of the northwest U.S. oyster populations. In 2006, some oyster hatcheries were experiencing mortality rates as high as 80 percent due to acidification accelerating the region's already-low pH. But by recirculating water, keeping stock away from fluctuations and increasing feed, the industry has returned to normal rates in the past few years.

Measures like this could also help protect fish populations, explained Munday, but he added that this might not necessarily be enough for species to adjust in time.

Additional factors beyond the ability to function under decreased pH, like habitat loss and behavioral changes, he said, may present even more immediate threats to marine species. At lower pH levels, many fish loose their ability to understand chemical cues that help them learn their environment and avoid predators.

Fish that lose their sense of predators "also expose themselves to further risk exhibiting bold behavior in the search for more food to meet their new energetic demands," he explained. "These kind of findings could have never been anticipated; we found them by virtue of asking seemingly unrelated questions."

How fast can adaptation happen?

Actual adaption potential remains one of the biggest unknowns, said Munday, and one of the biggest questions for the future, as will be adding in the other factors known to be simultaneously occurring in oceans worldwide.

"Now we are tasked with looking at adaptive potential amidst the combined effects of acidification and warming," he said.

Roberts said while the report tried to frame recommendations in an obtainable light, focusing on goals that be implemented right away, like limiting construction debris, sewage and pollution levels, the ultimate task of actually decreasing carbon emissions is further off.

"Emissions are of course the final and only real solution at the end of it all," said Roberts, "but we've got to be realists. Renewable energy sources won't be possible everywhere anytime soon, and the damage already done has been shown historically to take thousands of years to repair."

The last time the Earth's oceans experienced these kinds of carbon dioxide changes, the report found, was 56 million years ago, during the Paleo-Eocene Thermal Maximum, or PETM, when 2,000 to 3,000 petagrams of CO2 was released over 10,000 years.

The results killed a vast abundance of marine life, primarily calcifiers. Then it took the oceans roughly 100,000 years to rebalance. By comparison, today's changes are occurring at 10 times this rate, with projections of PETM levels by 2600 if emission levels remain the same.

Reprinted from Climatewire with permission from Environment & Energy Publishing, LLC. www.eenews.net, 202-628-6500

ClimateWire